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A. TITLE
IMPROVED BRIDGE STRUCTURE

15757 U.S. PTO
10705692



C. KNOWN PRIOR ART

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D. DISCUSSION OF PRIOR ART AND BACKGROUND OF INVENTION

The subject invention relates to bridge structures and is conceived as an improved structural arrangement that combines multiple types of support systems to increase the bridge strength and stability of the bridge.

The purpose of increasing a bridge strength is manifest when consideration is given to the fact that most highway bridges are now subjected to heavier loads, all with increasing frequency. This load factor is caused in large part by heavy truck traffic, along with the increased passenger vehicle traffic. These load factors yield considerable stress on a bridge's strength and stability. Railroad bridges are generally subjected to the same type of structural stress.

Moreover, in certain geographic areas, highways and railroad bridges are subjected to severe winds that appear to be increasing in intensity by reason of developing unusual weather patterns. These and other factors, including earth tremors, create a need for bridges of greater strength and stability, and as a result, the invention herein is conceived as a means to provide additional strengthening factor for bridges and the objects set forth below for the subject invention are directed accordingly.

In discussing the variant aspects of the subject invention, note is made that the inventive concepts herein apply to suspension bridge structural concepts, arch support structures and other structural systems, such as truss bridges, beam bridges or cantilever bridges, and the fact that the subject invention is described as being directed to only a few of such types of bridge structures shall not limit the scope of the subject invention, as embraced by the following described objects.

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E. OBJECTS

It is an object of the subject invention to provide an improved bridge structure;

Yet another object of the subject invention is to provide an improved, multi-support bridge support structure and system;

Another object of the subject invention is to provide an improved bridge structure having more than one type of basic support system;

Still another object of the subject invention is to provide an improved structural system for improving the strength of a bridge;

A further object of the subject invention is to provide an improved supplemental system for increasing the base support strength of a bridge structure;

Yet another object of the subject invention is to provide an improved structural system for bridge support purposes;

It is also a purpose of this invention to provide multiple systems for supporting a single bridge structure, which multiple systems are structurally cooperative and not physically antagonistic;

Another purpose of this invention is to improve existing bridge structure.

Other objects will become apparent from a reading of the following description in conjunction with the drawings.

F. DESCRIPTION OF DRAWINGS

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3 Figure 1 is a side elevational view of the subject invention shown in the
4 overall perspective of a total bridge structure;

5 Figure 2 is a perspective view of the subject under-support member used in
6 conjunction with the subject invention;

7 Figure 3 is an end elevational view, in cross-section, of the subject under-
8 support member, as embracing the under surface of a bridge deck;

9 Figure 4 is a side elevational view of the subject under-support member
10 shown as embracing the under surface of a bridge deck.

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G. DESCRIPTION OF GENERAL EMBODIMENT

1 The subject invention is an improv d bridge structure comprising th
2 use of both arch structural support systems along with suspension systems,
3 combined together to support a multiple bridge support structure, with such multiple
4 support systems being focused and combined through a unitary member in a center
5 portion of the bridge, with the unitary member being an under support member in
6 one embodiment, with such under support member supporting a portion of the
7 bridge deck. More particularly, the subject invention is focused on utilizing multiple
8 structural support systems for a bridge, with such multiple support systems being
9 centered on a longitudinally extending secondary under support member, which is
10 supported and held partially by the supplementary bridge support system, such
11 secondary support member structurally having multiple and varied support systems
12 and being adapted to provide an under support system as a supplementary support
13 mechanism for the bridge structure. In summary, the subject invention comprises
14 a secondary support system for a bridge to provide additional support to the primary
15 support system for the bridge, such secondary support system having its forces
16 focused on an undersupport system that is positioned beneath the bridge deck as
17 an undersupport member that helps hold the bridge deck, along with the support
18 provided by the primary support system.

19 In further summary, the subject invention is focused on the use and
20 deployment of an under-support member that is supported independently and
21 separate from the support member for the bridge, which under-support member is
22 basically a cradle like member that provides an uplifting force for the bridge deck.
23 This supporting force can be directed and applied to any portion of the bridge deck
24 and may include any means of system of support as supplementary to the main
25 support system for the bridge.

1 H. DESCRIPTION OF PREFERRED EMBODIMENT OF SUBJECT INVENTION

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3 The following description of a preferred embodiment is set forth as one
4 specific embodiment. Such description of a preferred embodiment shall not be
5 considered as limiting the scope of the subject invention to only the type of bridge
6 described with its multiple support systems.

7 Attention is directed at first to Figure 1 of the drawings in which a preferred
8 embodiment of the subject invention is shown. Specifically shown in Figure 1 is a
9 bridge member 10 incorporating features of the subject invention, such bridge
10 member having an upper deck 20 over which deck vehicular traffic traverses. As
11 can be seen, bridge deck 20 is generally a horizontal, longitudinally extending
12 structure having an upper surface 30 and a lower surface 40. The upper surface
13 of the bridge deck may be other than horizontal in some embodiments, however,
14 and may be curved upwardly in a convex manner to increase the vertical spatial
15 distance under the bridge for accommodation of such things as ship masts passing
16 underneath. It is the bridge deck that is the ultimate structural object of the bridge
17 support system which is the subject of the invention, as in any conceived bridge
18 support system.

19 The bridge 10 and the bridge deck 20, as shown in the drawings, is
20 structured to extend from the respective upper portions 50A and 50B of opposing
21 banks 60A and 60B respectively framing the opposing sides of a gorge, valley,
22 ravine or river 70 as schematically shown in Figure 1. The bridge deck 20 is, as
23 stated above, the ultimate structural focus of any bridge support system or the
24 multiple support system described in the application, as the bridge deck is adapted
25 to bear the weight and stress in any bridge system. As seen, in this respect, the
26 bridge deck 20 has opposing ends 80A and 80B affixed directly or indirectly to the

1 adjoining upper portions 50A and 50B of opposing upper banks 60A and 60B.
2 Moreover, as seen in Figure 1, the bridge deck 20 may be comprised of two
3 opposing horizontally projecting sections 85A and 85B adjoining at the respective
4 mating ends 85A and 85B at what is optimally the medial portion 90 of the bridge
5 deck. The bridge deck 20 may be formed otherwise as a unitary member or
6 comprising more than two sections interconnected by some means.

7 Again, as stated, the deck 20 is the main focus of any bridge support system,
8 and in this invention, the support system that is generally provided herein is a dual
9 or multiple support system for the bridge deck 20. Thus, at all times, the bridge
10 deck 20 in the subject invention will have a primary support structural mechanism
11 and a secondary support system, or alternatively stated, there will be multiple
12 support systems for the bridge 20, and either support system may be considered
13 primary or secondary. Moreover, in the subject system, more than two support
14 systems can be used to support the bridge structure. Furthermore, while the
15 support systems described in the preferred embodiment are directed to suspension
16 and arch support systems other support systems may be used to implement the
17 concept of the subject invention. The intent of this invention is to provide such
18 secondary support system or systems with their respective attendant support
19 forces, so that they interact cooperatively, so that the static forces of each attendant
20 support system does not interfere with or tend to weaken or cancel out the support
21 forces provided by the other support systems, but rather complement one another
22 so that the overall support system forces holding the bridge deck are augmented.

23 The foregoing bridge structure as described in the preferred embodiment is
24 basically a conventionally-structured arch type abutment bridge utilizing opposing
25 support arches 100A and 100B as the primary support elements for the bridge 10
26 and bridge deck 20. This arch support structure as described is considered to be

1 conventionally-structured to be self-supporting by its intrinsic structure, and
2 therefore, in ordinary circumstances, needs no additional support structure to
3 uphold the bridge deck 20. Additionally, more than two arch support members may
4 be used on a given bridge structure utilizing concepts of this invention. The
5 subject invention is set forth as a supplemental support system for the bridge 10 as
6 described with its attendant base arch support system. Moreover, it is noted that
7 the concepts of this invention are equally applicable to other than arch type bridge
8 structures.

9 The following described structural aspects, which comprise the main
10 substance of the subject invention, are adapted to aid in the underlying support
11 provided by opposing abutment type arch members 100A and 100B, as described
12 above. As seen, the subject invention and the structural concepts set forth herein
13 are adapted to be supplementary support for such base abutment arch members
14 100A and 100B to add to the support strength for the bridge 10 as more fully
15 described below. Moreover, it is to be stressed that more than two abutting arch
16 members may be utilized in conjunction with the subject bridge structure.

17 More specifically as seen in the drawings and particularly Figure 1, the
18 opposing outer ends 80A and 80B of the bridge deck 20 are integrally affixed
19 directly or indirectly to the opposing upper portions 50A and 50B of the river banks
20 60A and 60B, as seen. It is not critical that the opposite ends 80A and 80B of the
21 bridge deck 20 be integrally positioned into a portion of the opposing banks 60A
22 and 60B respectively as represented in Figure 1.

23 In the usual structural arrangement for an arch support type bridge, such as
24 bridge 10, the bridge deck 20, as stated, is directly or indirectly supported by the
25 arch members 100A and 100B. In the bridge 10 represented in Figure 1, the bridge
26 deck 20 is positioned and affixed such that the approximate medial portions of the

1 under surface 40 of bridge deck 20 are integrally positioned and affixed over the
2 upper surface portions 170A and 170B respectively of the respective first and
3 second support arch members 100A and 100B as seen. Other support and
4 attachment means between the respective arch members and bridge deck may be
5 utilized however.

6 Additionally, as observed in Figure 1 in the structure of bridge 10, vertical
7 support stanchion members 180A and 180B are connected in a supporting position
8 between the upper surface 170A of first support arch member 100A and the lower
9 surface 40 of deck 20. In similar manner, vertical support stanchion members 190A
10 and 190B are supportively interconnected between the upper surface portion of
11 support arch 100B and the right portion of lower surface 40 of deck 20. As can be
12 readily observed from the side elevational view of Figure 1, support arch members
13 100A and 100B, with such vertical stanchion, as interconnected to the bridge deck
14 20 are represented as being symmetrically arranged in order to achieve maximal
15 and optimal support features for the bridge 10. However, in some circumstances,
16 this desired symmetry cannot be realistically implemented in every circumstance.
17 This latter facet does not detract from the implementation and realization of the
18 structural practicality of the subject invention. Moreover, any number of vertical
19 stanchions may be used between the arch and bridge deck without detracting from
20 the conceptual scope of the invention herein.

21 As thusly described, the bridge 10 is structured similarly to a conventional
22 arch type bridge, the structural arrangements of which are well known. The
23 additional support system or systems, which are described hereafter in this
24 application are considered unique, particularly in the manner to which the
25 supplementary forces are directed to the under surfaces of the bridge deck. These
26 latter innovative concepts are the focus of this patent application and are described

1 in detail as follows.

2 As an overall perspective, it is to be str ssed that in the primary and
3 preferred embodiment of the invention herein, the subject support system is focused
4 through a support member that provides upwardly lifting forces on the bridge deck,
5 and preferably such forces are applied directly or indirectly up through the lower
6 surface of the bridge deck. It is not necessary, however, that the supplementary
7 forces be applied to the under-surface of the bridge deck, but rather may be applied
8 upwardly on any portion of the bridge deck. However, in the primary embodiment,
9 an under-support member 200 is used as the structural mechanism to focus the
10 supplementary force on the bridge deck as more fully described below.

11 In the embodiment shown in Figures 1, 2 and 3 the under-support member
12 200 is shown with the upper surface 210 thereof as being relatively flat and
13 uniplanar, or more simply as being uniformly flat. In another embodiment of the
14 under-support member, as shown in Figure 4, the upper surface 210 of the under-
15 support member is shown as having a slightly curved upper surface, which
16 curvature is seen as being convex as from an upper position looking downwardly
17 on such upper surface. In this latter respect, as more fully discussed below, the
18 under-support member 200 is adapted to be positioned such that the upper surface
19 210 of the under-support member 200 embraces conformingly the bottom surface
20 portions 230A and 230B of an arbitrary length of the adjoining upper portions of
21 opposing arch members 100A and 100B, as more particularly seen in Figures 1, 2,
22 3 and 4. Thus if the adjoining bottom surface portions 230A and 230B of the
23 adjoining arch members 100A and 100B are curved, the corresponding curved
24 upper surface 210 of the under-support member 200 will more conformingly seat
25 fully and securely against the lower surfaces 230A and 230B of the adjoining arch
26 members 100A and 100B for focusing and directing the secondary support provided

1 by the under-support member to the lower surface of the bridge deck. In this
2 regard, the under-support member is in turn statically supported in a lifting manner
3 by the secondary support forces more fully discussed below.

4 It is to be stressed that upper surface 210 of under-support member 200 that
5 embraces upwardly in a lifting manner the under surface 40 of the bridge 10 or
6 bridge deck 20 can be correspondingly shaped or configured to conform to
7 whatever type of bridge structure is utilized. Consequently, it is to be understood
8 that the subject support system, with the attendant under-support member, is not
9 limited to arch type bridges. This under-support system is further described in
10 detail in later portions of this application below.

11 In the preferred embodiment of the subject invention, the secondary support
12 system set forth herein, focuses its static support forces through the under-support
13 member so that such under-support member 200, as discussed above, provides
14 secondary lifting forces to supplement the support of the opposing arch members
15 100A and 100B. Shown in the drawings is one example of such a secondary
16 support system which is specifically a suspension system, as shown in Figure 1.
17 It is understood that other support systems may be used as an additional support
18 system for the bridge and the inventive concepts herein are not to be considered
19 limited to a suspension system as such a secondary support system.

20 More specifically, the suspension system shown in Figure 1, is structured
21 in its basic arrangement as being substantially conventional. To this end shown in
22 Figure 1 is a suspension structural system 300 that is adapted to incorporate
23 support forces to uphold under-support member 200. Included in this suspension
24 support system 300 and attendant structures are opposing suspension support
25 towers 310A and 310B which are respectively embedded into the uppermost
26 portions 50A and 50B of opposing river banks 60A and 60B as seen. These

1 support towers 310A and 310B have lower base portions 320A and 320B that are
2 fixed in position, extending vertically upwardly, as seen. The upper ends 330A and
3 330B of each support tower 310A and 310B are preferably, but not essentially, at
4 an equal height to each other relative to a base point such as the bridge deck 20
5 or some other base reference point, however, this latter feature is not critical.

6 As can be seen from the drawings, the respective suspension support towers
7 310A and 310B have at least one set of primary bridge support cables, such as
8 cables 340A and 340B and cables 350A and 350B for suspension support.
9 Additional support cables may be utilized. Each of these support guy cables are
10 generally anchored at a distance away from the bridge 10 and towers 310A and
11 310B. The suspension support towers 310A and 310B generally each have one or
12 more direct tower support cables such as cables 360A and 360B extending
13 downwardly from upper portions of each suspension support tower, with attachment
14 indirectly or directly to some portion of the ground for supporting the towers. In the
15 embodiment shown in the drawings, the primary support cables 340A and 340B and
16 350A and 350B extend downwardly to the bridge 10 from suspension support tower
17 310A and 310B which each such suspension cable extending downwardly towards
18 the center portion of bridge 10. As shown in the drawings, it must be indicated that
19 the number of suspension support cables, as well as the number of suspension
20 support towers, and the precise structure thereof may vary from that described first
21 above. Moreover, stress is to be made that the subject suspension system as
22 described is relatively simplistic and is relatively standard or conventional as
23 described to this point. The inventive concept of the invention herein is centered
24 on the use of a secondary support system of bridge 10 provided by the above
25 described suspension support system, as preferably directed upon and otherwise
26 focused with the attendant static forces of the secondary support system on the

1 under-support member 200 as briefly described above and more fully described
2 below. To this end, the suspension support cables 340A and 340B from suspension
3 support tower 310A are affixed to a portion of the under-support member 200 so to
4 provide upwardly lifting support for such under-support member, and in similar
5 fashion suspension support cables 350A and 350B emanating from the suspension
6 support tower 310B are also connected to a portion of the under-support member
7 200; as seen. It is optimal for this latter purpose that the respective suspension
8 cables 340A and 340B and 350A and 350B be connected to a portion of the under-
9 support member 200 with each set of cables affixed in equi-posed disposition on the
10 under-support member 200 relative to one another. This connection is for basic
11 symmetry and balance purposes, as seen in Figure 1 so that the under-support
12 member 200 is supported by the respective cable members and is held in a level
13 position relative to a base horizontal reference, or any other point of reference.

14 The general function of the under-support member 200, as set forth above,
15 is to help provide additional support for the opposing abutting arch members 100A
16 and 100B in the support function of bridge 10, with the static upwardly pulling forces
17 provided by the suspension cable members 340A and 340B and 350A and 350B.
18 For this purpose, the under-support member 200 is adapted to function as a lifting
19 member independently supported irrespective of whether the arch support members
20 100A and 100B directly and physically abut each other or are directly supportive of
21 the bridge deck 20, or even with each such arch directly contacting each other.

22 As can be determined, both the vertical and horizontal static force
23 components of each such support arch member 100A and 100B provide necessary
24 upward support for bridge deck 20, as well as the necessary horizontal forces to
25 statically project the respective adjoining horizontal portions of the bridge deck 20
26 towards one another. In some bridge structural arrangements, more than two

1 upright arch members may be used as basic support structures, however, and th
2 concepts of the invention herein will be equally applicable in such latter
3 circumstances.

4 Specific attention is directed to Figures 1, 2, 3, and 4 demonstrating the
5 supplementary under-support structure which is focused on the under-support
6 member 200 that is basically formed as a longitudinally extending member having
7 a longitudinally extending base member 205 that extends over the longitudinal
8 extent of the under-support member with opposing ends 400A and 400B on the
9 under-support member. More particularly, the under-support member 200 is a
10 longitudinally extending member with an upper surface 210 and a lower surface 225
11 and may be of such a length that equals the entire length of the bridge deck 20 or
12 may be shorter relative to the length of the bridge deck, as shown in Figure 1.

13 In the preferred embodiment of the subject invention, the under-support
14 member 200 has laterally disposed upwardly extending support walls 430A and
15 430B that extend partially or completely along the entire length of the under-support
16 member 200. As stated, in the embodiment shown in the drawings, the lateral
17 support walls 430A and 430B are vertically disposed and integrally affixed to
18 opposing lateral sides 440A and 440B of the under-support member, along the
19 entire length of the under-support member 200, as seen. In the embodiment shown
20 in the drawings, the lateral, vertically disposed support walls 430A and 430B are
21 joined to the base member 205 of the under-support member 200 such that the
22 lateral walls are disposed perpendicular to the upper surface 210 of the base
23 member of the under-support member 200 as seen. This latter perpendicular
24 relationship is not critical to the subject invention and is not essential that the lateral
25 side walls 430A and 430B described be disposed along the precise sides of the
26 under-support member. It is also not mandatory to implementation of the subject

1 invention that there be lateral walls affixed or formed on the base member 205 of the
2 under-support member 200, so long as there is some means to affix auxiliary
3 supporting members such as suspension support cables described above to the
4 base member.

5 As can be seen from Figures 2, 3 and 4, the under-support member 200, with
6 its longitudinally extending base member 205 and laterally disposed vertical walls
7 430A and 430B form what may be viewed as a longitudinally extending channel
8 shaped member being open at the top as well as open or exposed at its opposing
9 ends. What is thus essentially formed is a channel shaped cradle like member
10 formed as the basic structure for the under-support member 200 in the main
11 embodiment of the invention. However, as described other structural arrangements
12 may be used for the under-support member and it may be limited to a flat uniplanar
13 member or any other structural arrangements that can focus uplifting forces
14 upwardly to the bridge deck.

15 As shown in the drawings, the suspension cable members 340A and 340B,
16 and 350A and 350B may be attached to the under-support member 200 by being
17 affixed to portions of vertical side walls 430A and 430B as seen in Figures 2, 3 and
18 4, or may be affixed to side or other portions of the base member 205 of the under-
19 support member 200 if the under-support member has no vertical sidewalls. Other
20 attachment arrangements may be used in this regard.

21 In some embodiments of the subject invention, the under-support member
22 may be formed as an enclosed sleeve member having a hollow longitudinally
23 extending chamber into which chamber the mating ends of support arches 100A and
24 100B are placed along and adjoining portions of the bridge deck. Other enclosed
25 or open structural arrangements may be used for the bridge under-support member.

26 As stated above, the under-support member 200 as supported by the

1 described suspension cables, is positioned under the lower surfaces 230A and 230B
2 of the abutting arch members 100A and 100B, in a conforming manner so that th
3 upper surface of the under-support member conformingly embraces in a flush
4 manner such undersurface areas of the abutting arch members. This upward pull
5 by the suspension cables 340A and 340B and 350A and 350B is such that the upper
6 surface 210 of the under-support member 200 is drawn upwardly against the
7 immediately adjoining under surfaces 230A and 230B of the abutting arch members
8 100A and 100B, as seen in the drawings. In this regard, the length of the under-
9 support member 200 is shown as being relatively short and the upper surface areas
10 of the opposing arch members may be relatively flat, as shown in the embodiments
11 in Figures 2 and 3, however, on the other hand, as stated, if the under-support
12 member 200 is relatively long, the upper surface 205 is preferably curved, slightly
13 upwardly, to accommodate the curvatures of the surfaces of the abutting arch
14 members. This latter feature functions to both maximize the impact of the upward
15 static forces from the suspension members described as well as evenly distributing
16 the force load over and to the lower surfaces of the abutting arch members. This
17 latter facet will maximize the supportive feature of the under-support member 200
18 as seen in the drawings and as described. Moreover, in order to maximize the
19 support, the under-support member 200 is best placed under the medial part of
20 bridge deck 20, however, this aspect is not critical to the implementation of the
21 subject invention.

22 One of the advantages of the subject invention is that the under-support
23 member, as supported by the suspension system or other support system, can be
24 used to retrofit an otherwise weakened bridge structure where the main support
25 system has been weakened by erosion or deterioration of the components of the
26 main support system. This retrofitting can obviously be accomplished by positioning

1 the under-support system under the existing bridge deck with some form of auxiliary
2 support such as the suspension system described above. Moreover, in some
3 embodiments, the under-support member may be braced directly up against the
4 lower surface of the bridge deck. This aspect is not shown in the drawings.

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